

Microbeam Imaging of Crystals by Coherent Diffraction at 34-ID-C

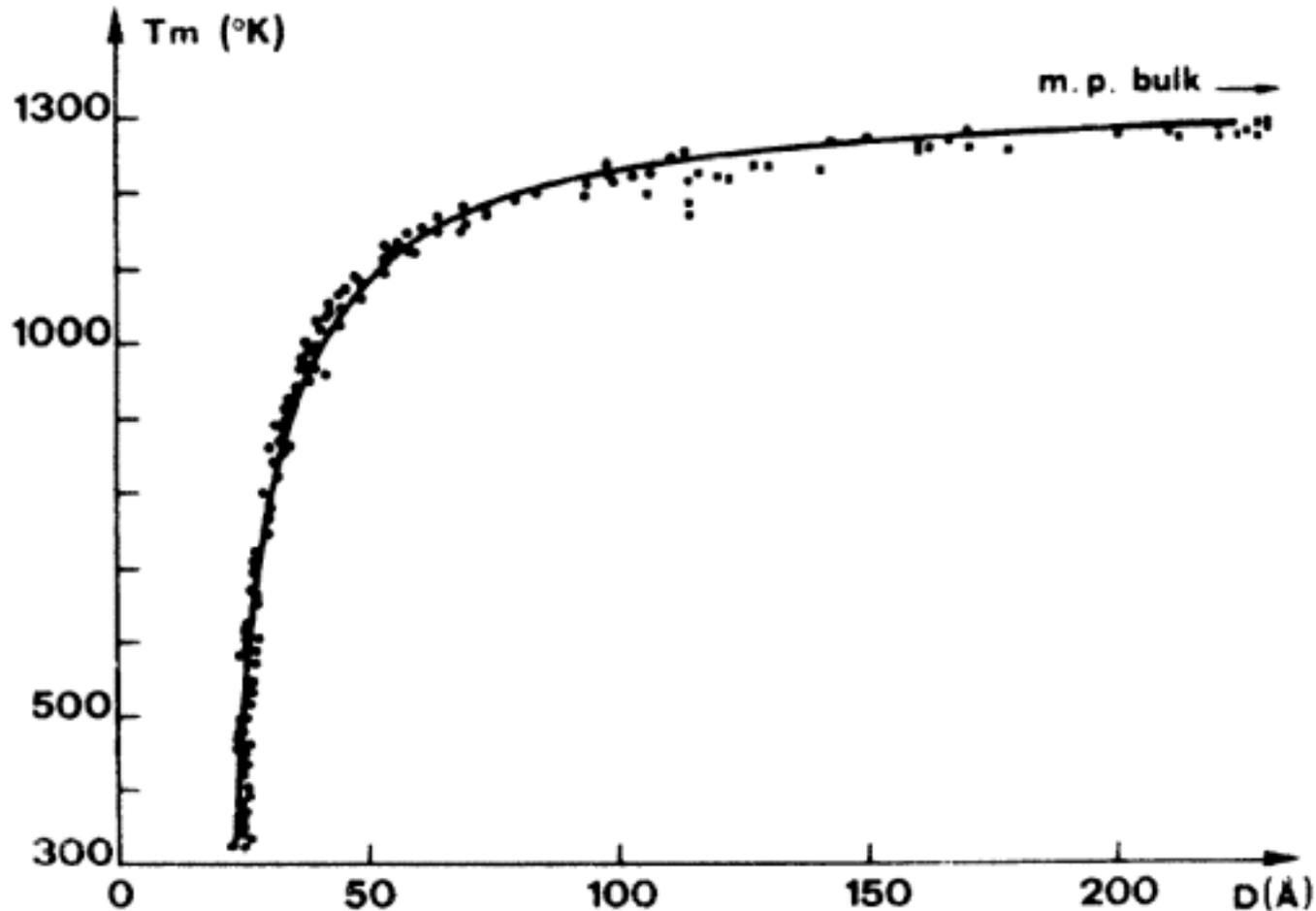
- Ian Robinson
- Ivan Vartanyants
- Franz Pfeiffer
- Mark Pfeifer
- Garth Williams
- Wei Zhang
- Curtis Benson

University of Illinois

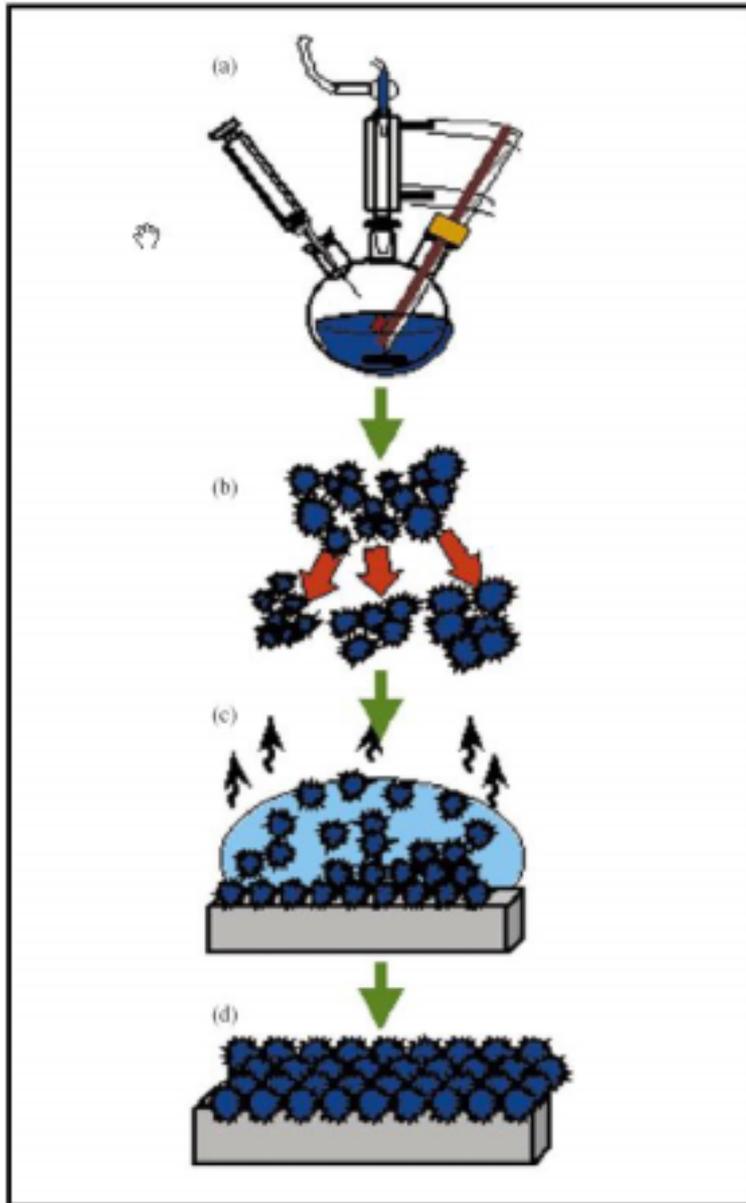
SAC Review of APS
Jan 2004

Size-dependent Melting of Au Particles

P. Buffat and J-P. Borel, Phys. Rev. A 2287-97 (1975)



Chemical Synthesis of Nanocrystals



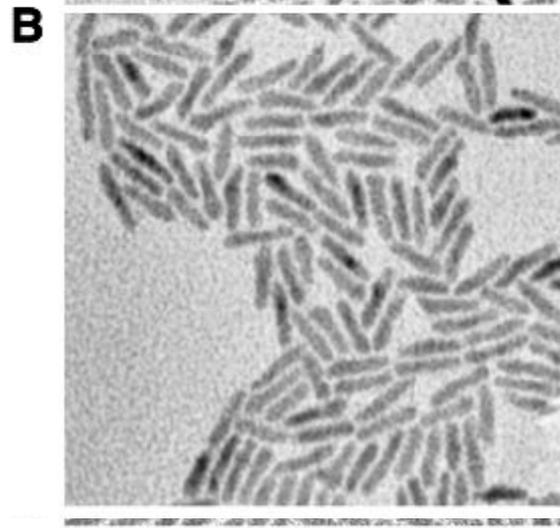
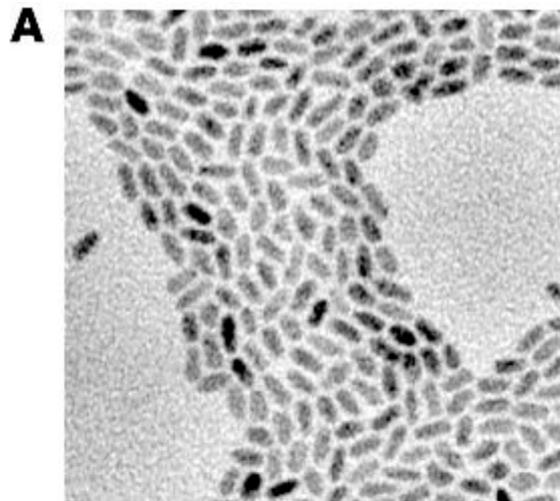
- Reactants introduced rapidly
- High temperature solvent
- Surfactant/organic capping agent
- Square superlattice (200nm scale)

C. B. Murray, IBM J. Res. & Dev.
45 47 (2001)

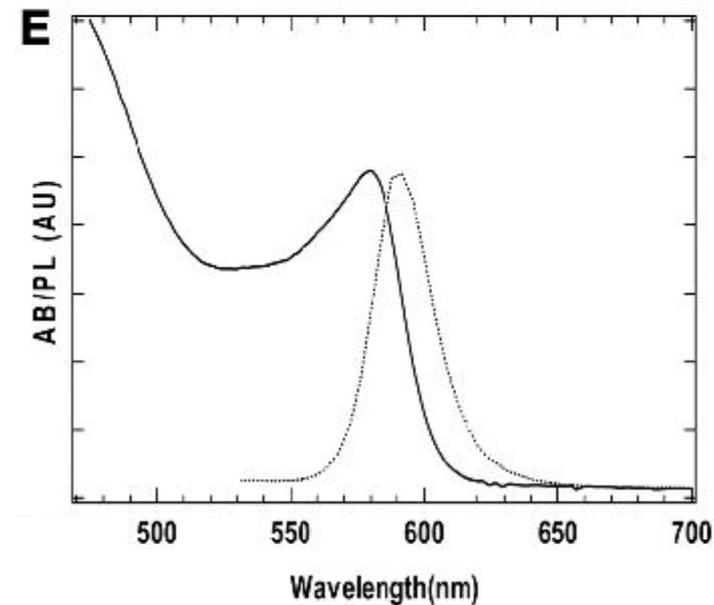
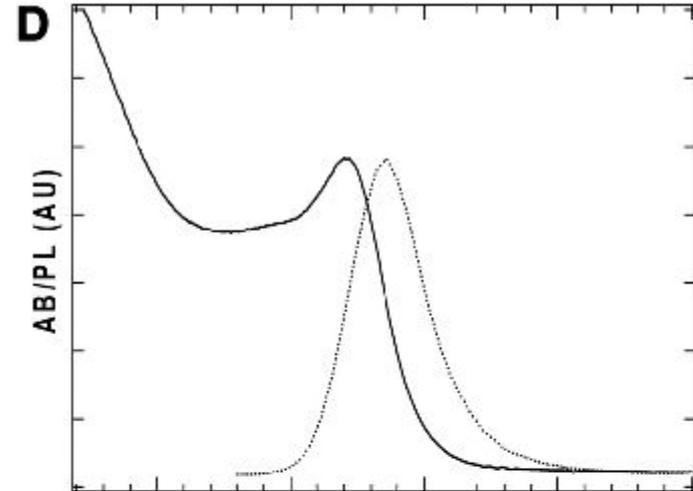


Rod-like Nanocrystals of CdSe

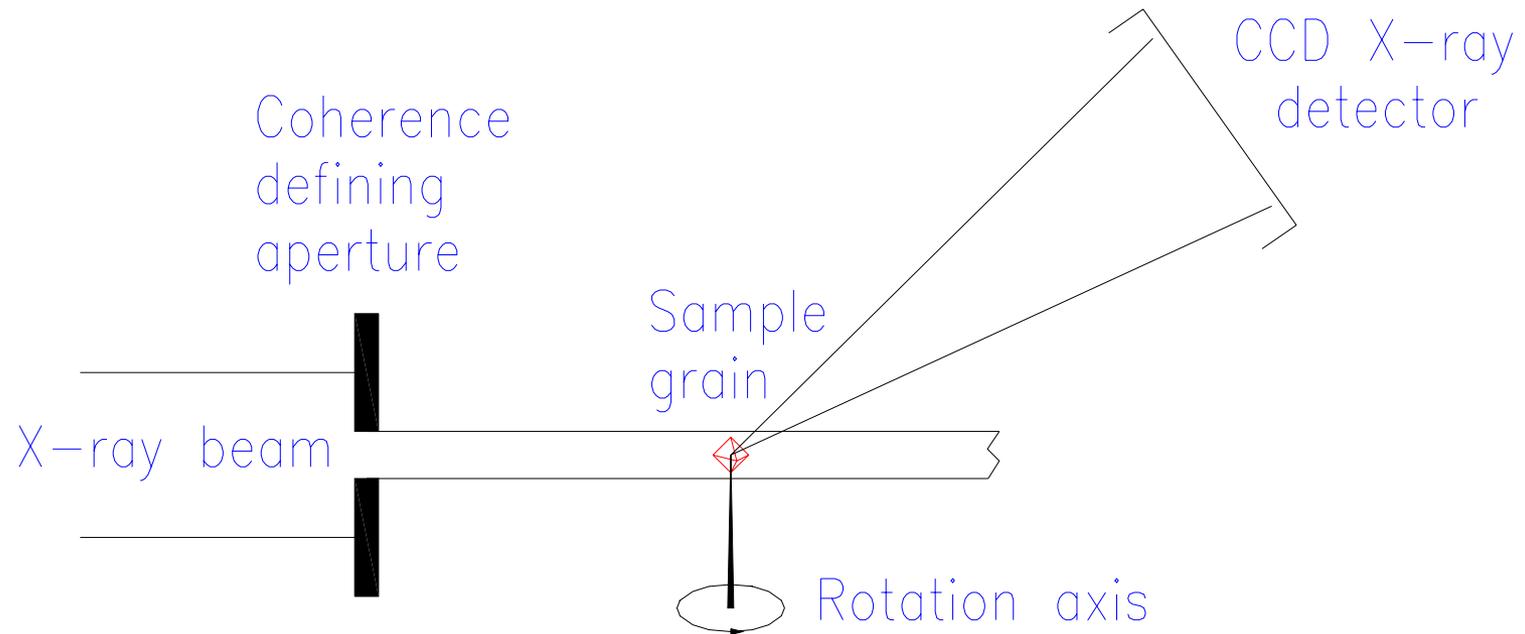
J. Hu et al., Science **292** 2060 (2001)



100 nm

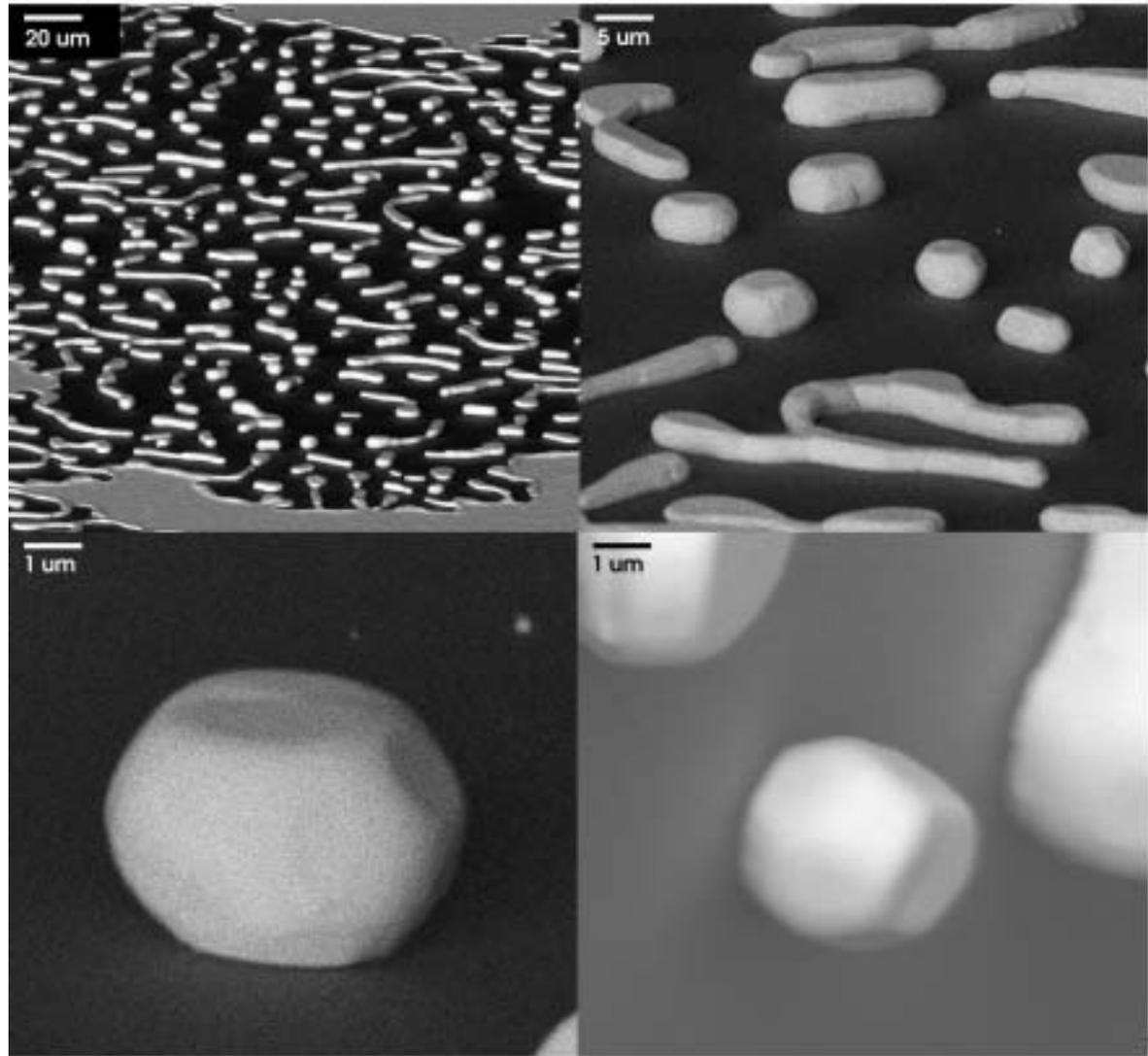


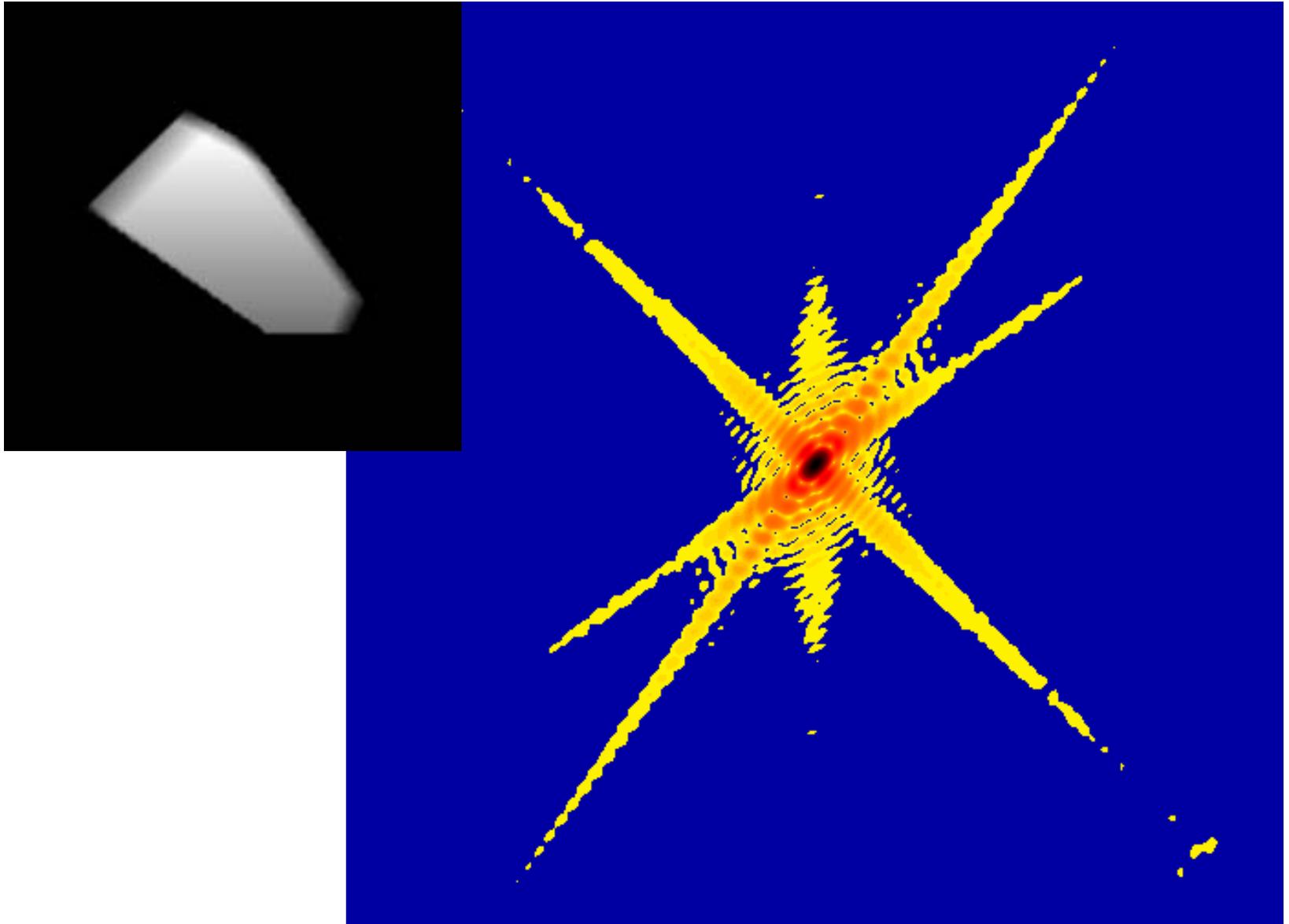
Lensless X-ray Microscope



SEMS

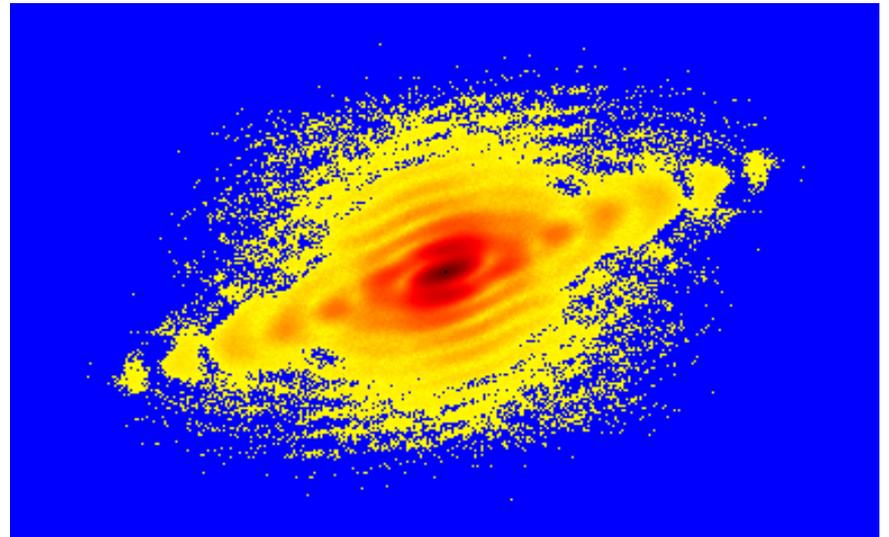
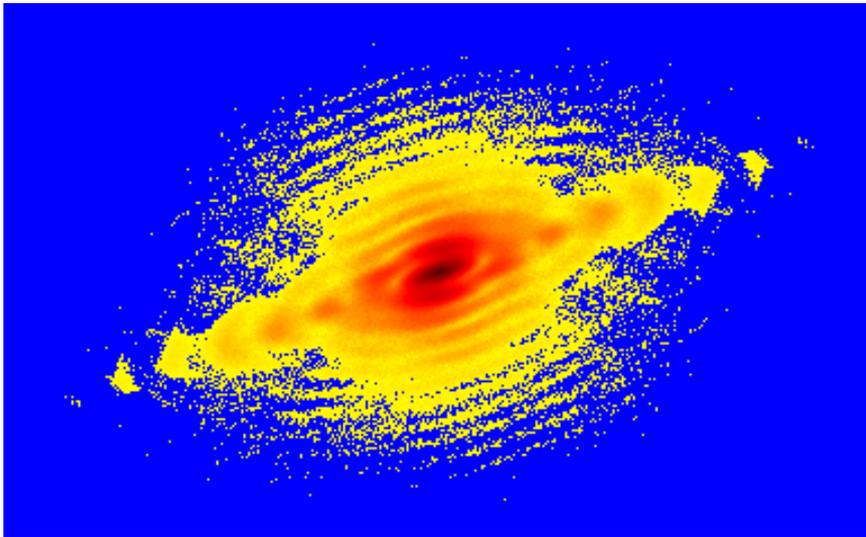
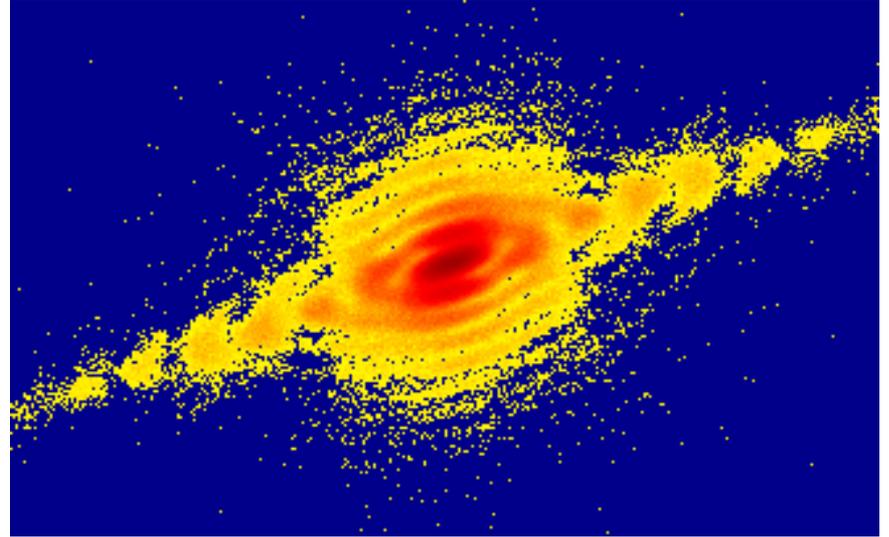
- Au blanket film
- Quartz substrate
- Annealed at 950°C for 70 hrs.





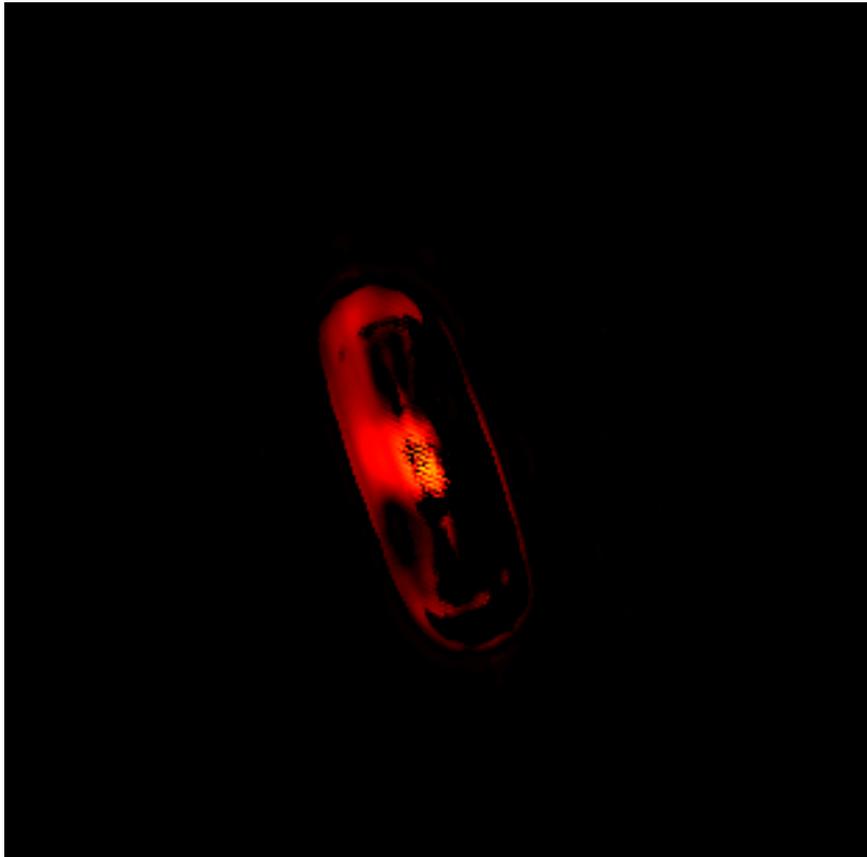
Symmetrized Data and two best fits

Chisq=0.0005

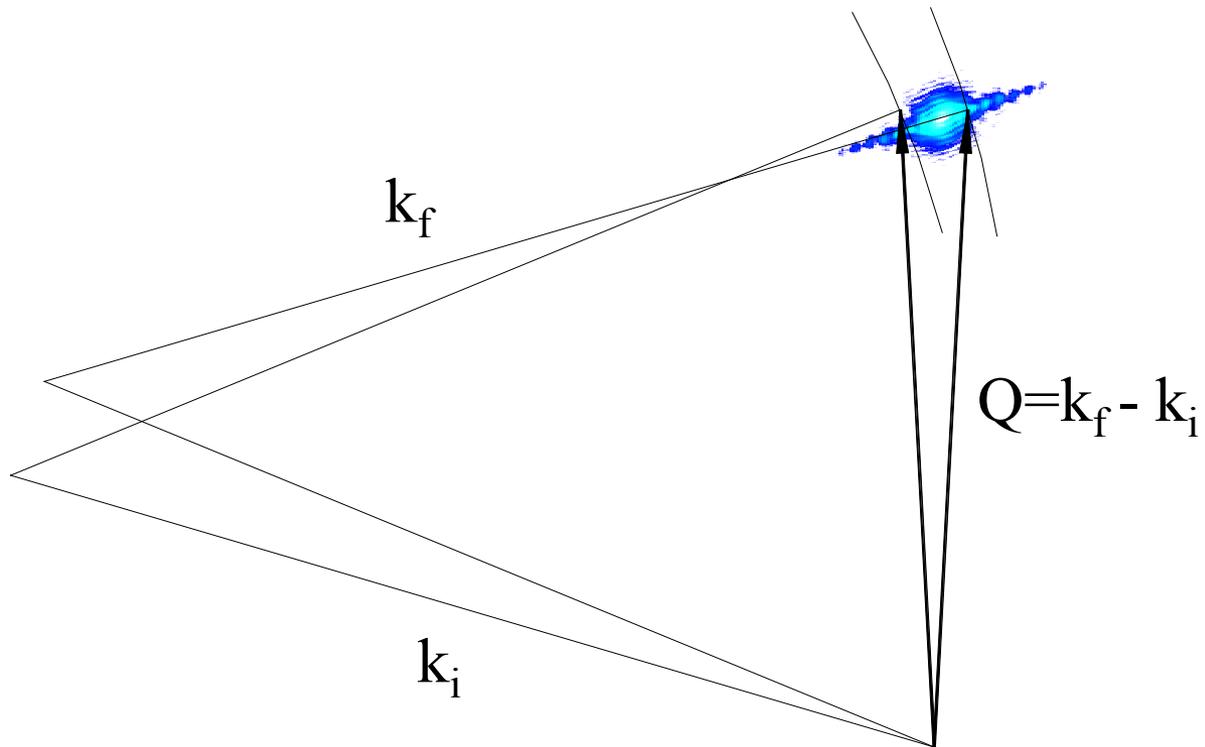


2D Reconstructions

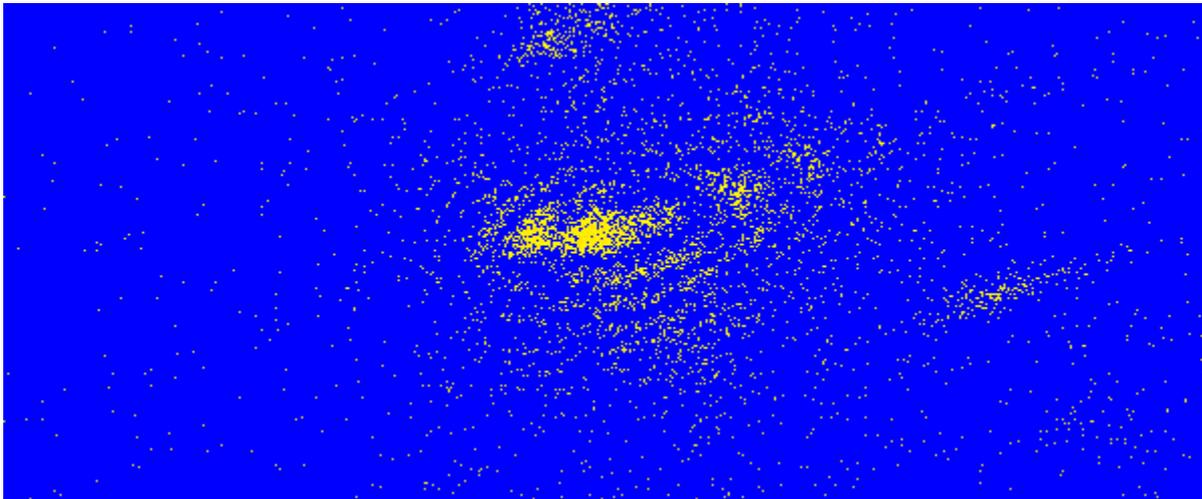
chisquare = 0.0005

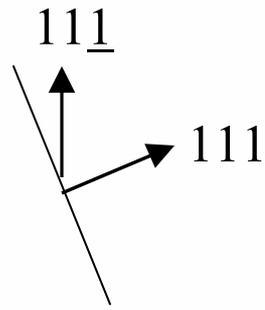
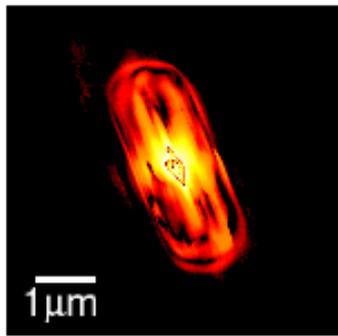
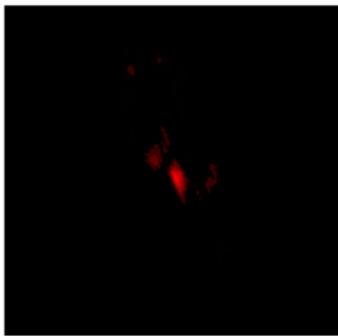


3D Diffraction Method

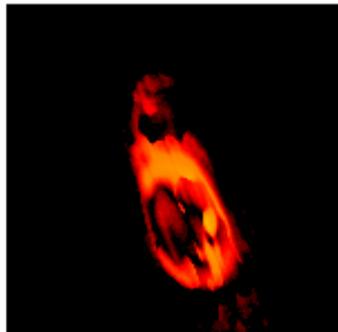
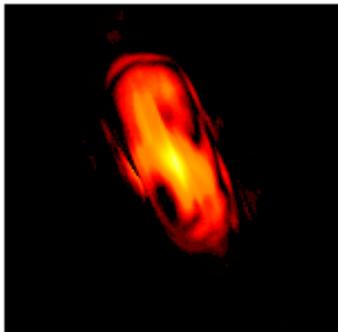
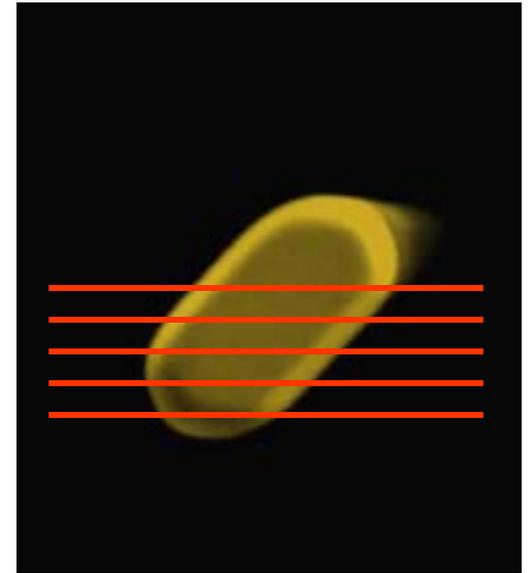
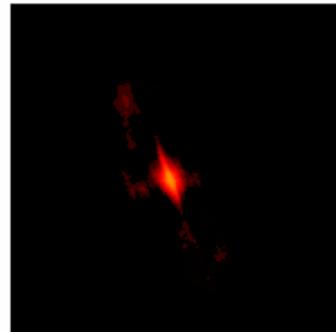
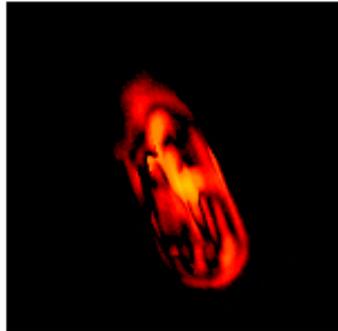
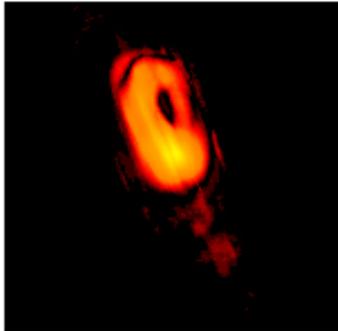
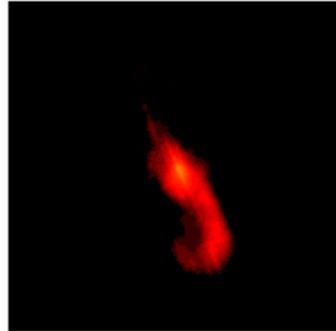
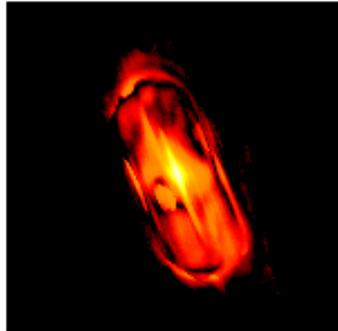
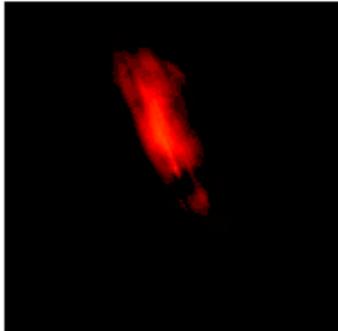


3D Diffraction Data 1 micron Au crystal



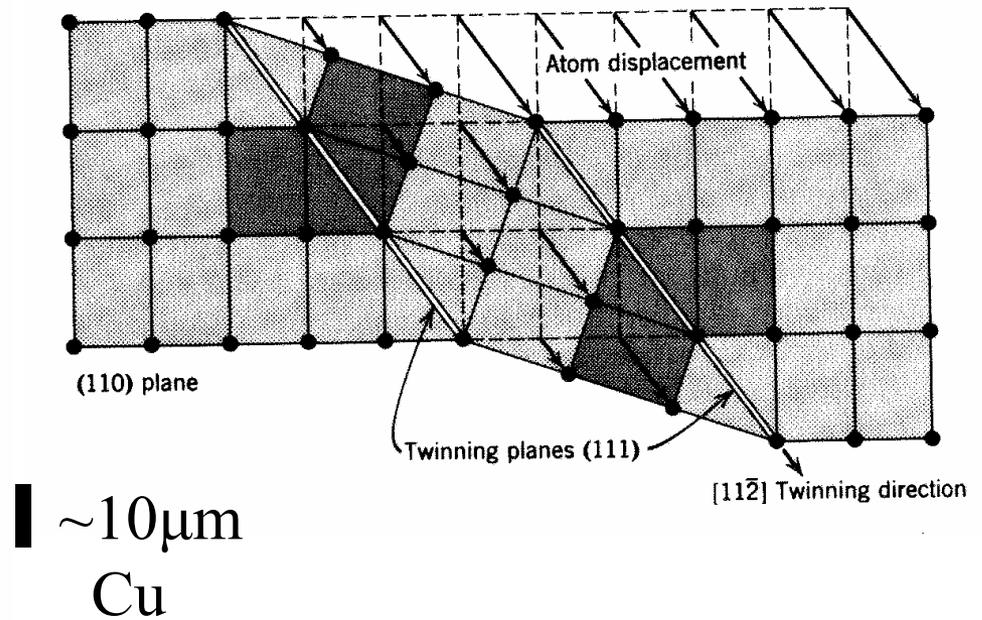


Slices through
plan view SEM:

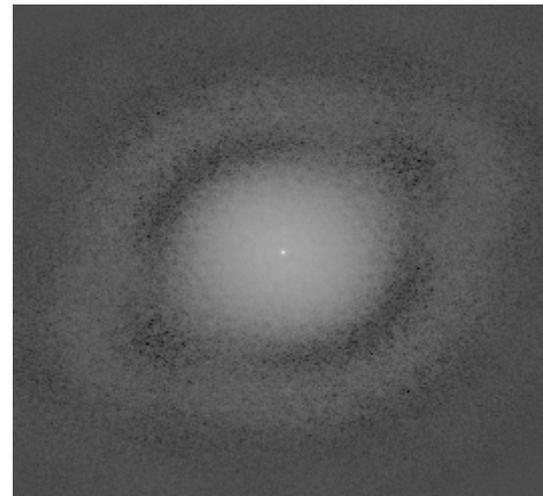
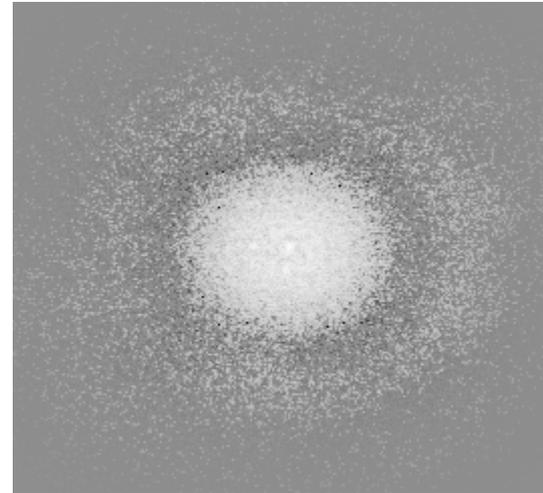
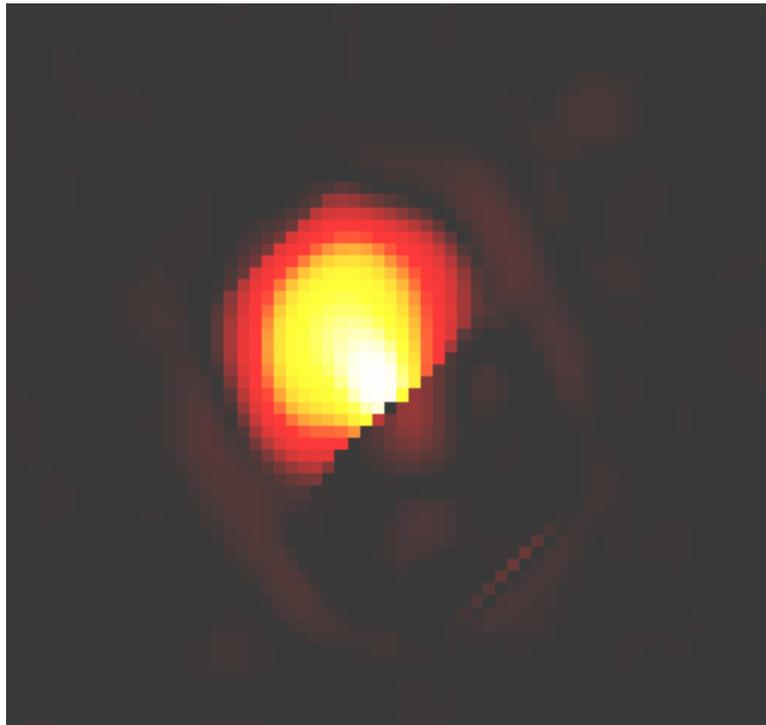


Twinning in deformed FCC metals

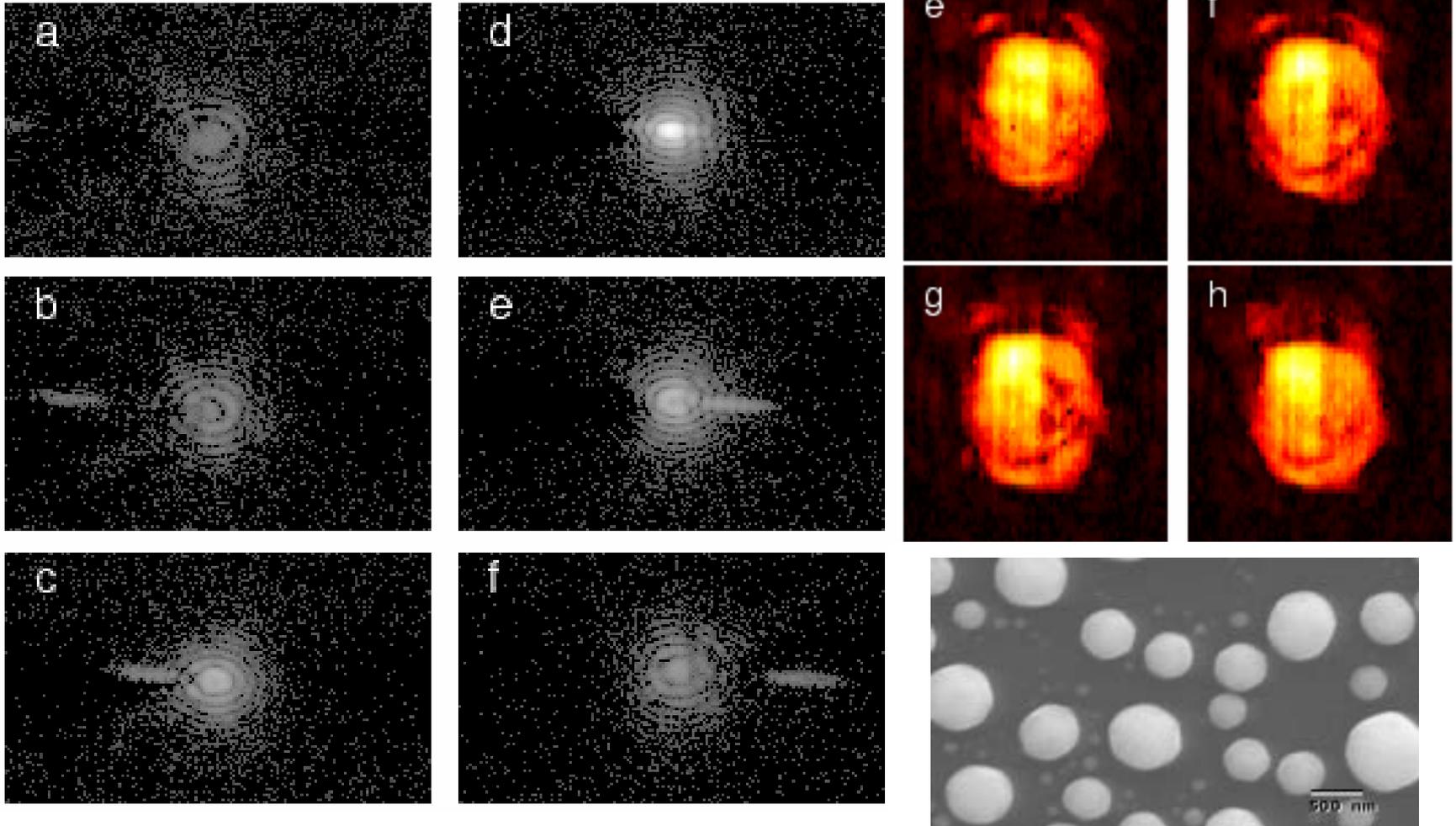
J. Wulff, "Structure and Property of Materials III" (1965)

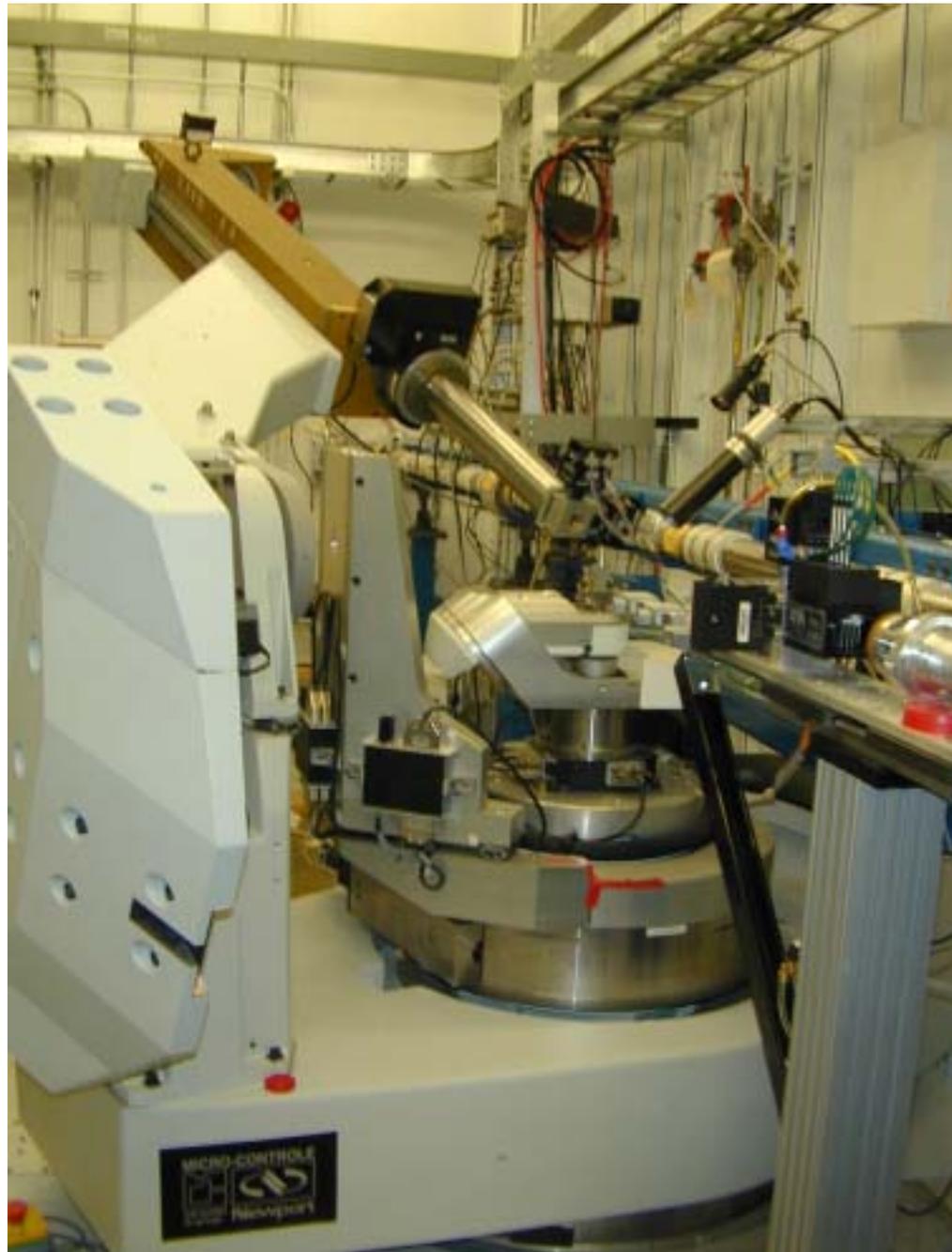


Reconstruction of Pb Nanocrystal

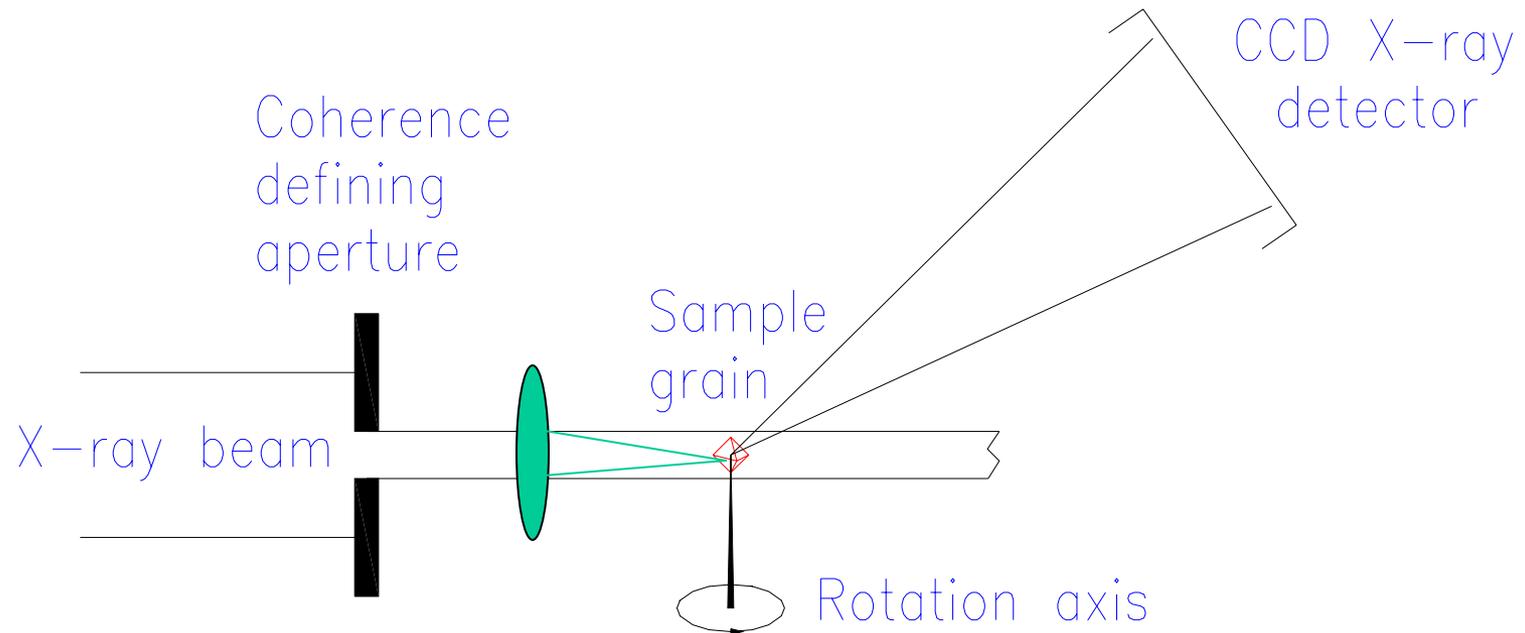


3D reconstruction of Pb nanocrystals

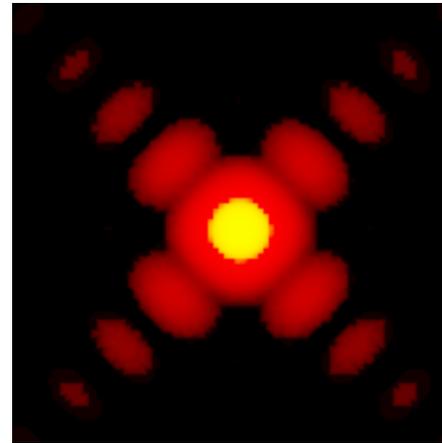
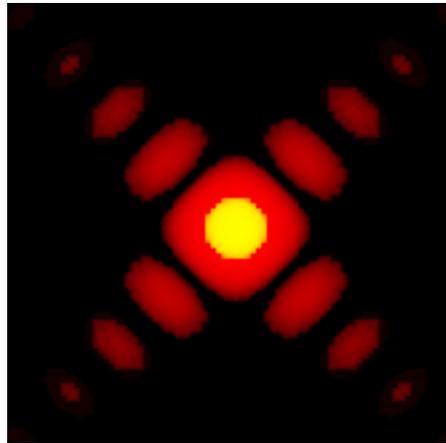




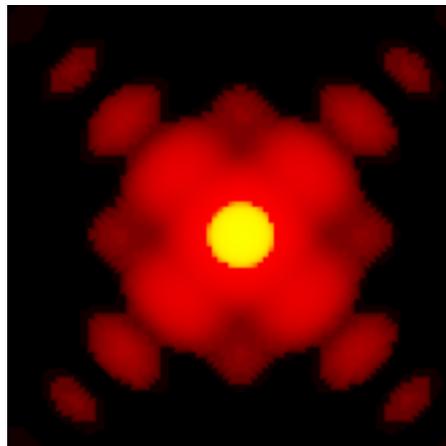
Lensless X-ray Microscope



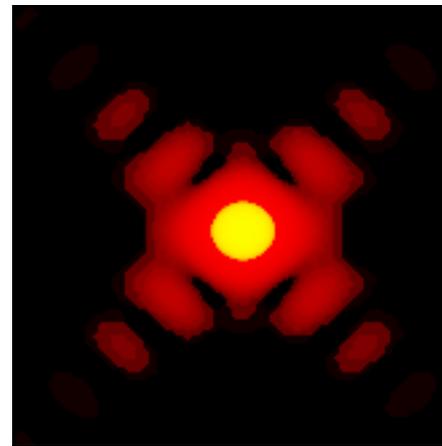
Spherical and cylindrical waves



$\pi/4$

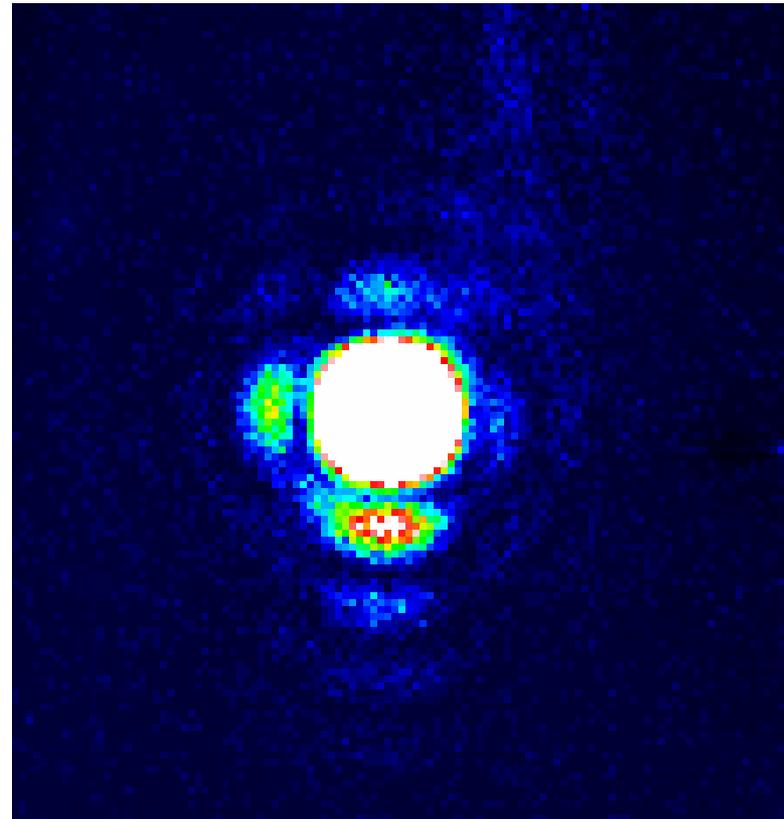
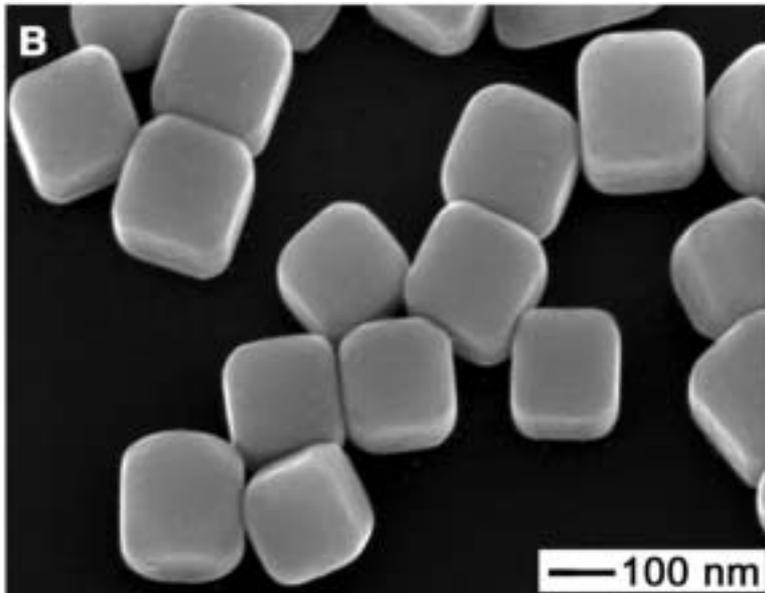


$\pi/2$



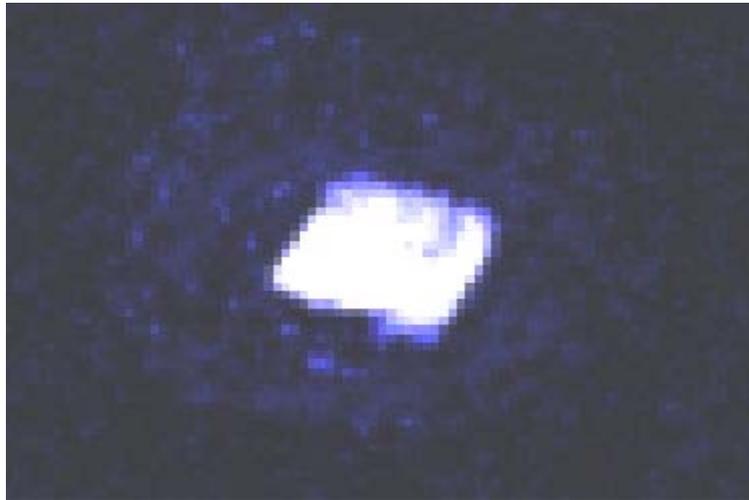
$\pi/4$ (x)

Chemically Synthesized Silver Nanocubes

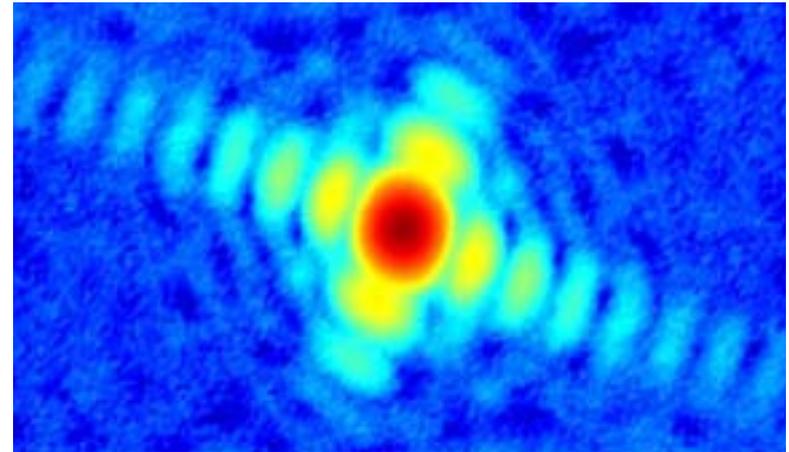
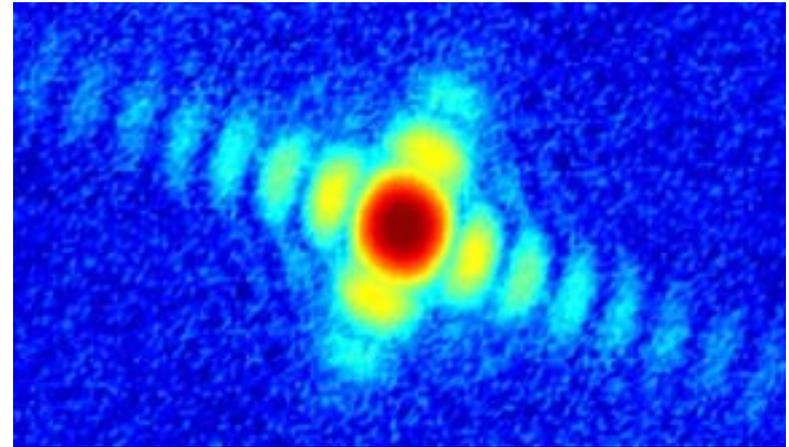


Yugang Sun and Younan Xia,
Science 298 2177 (2003)

Reconstruction of Ag Nanocrystal

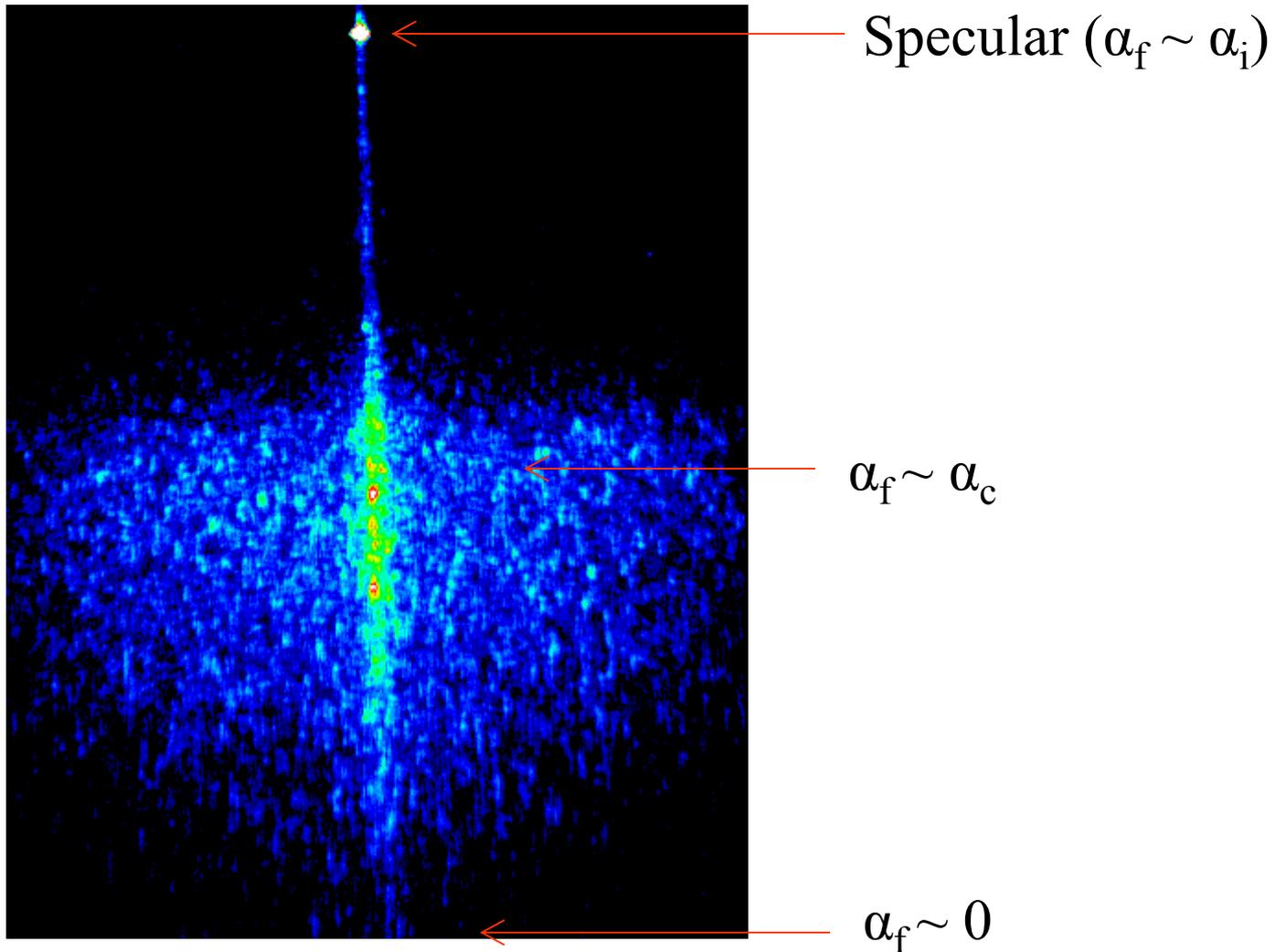


↔
200nm



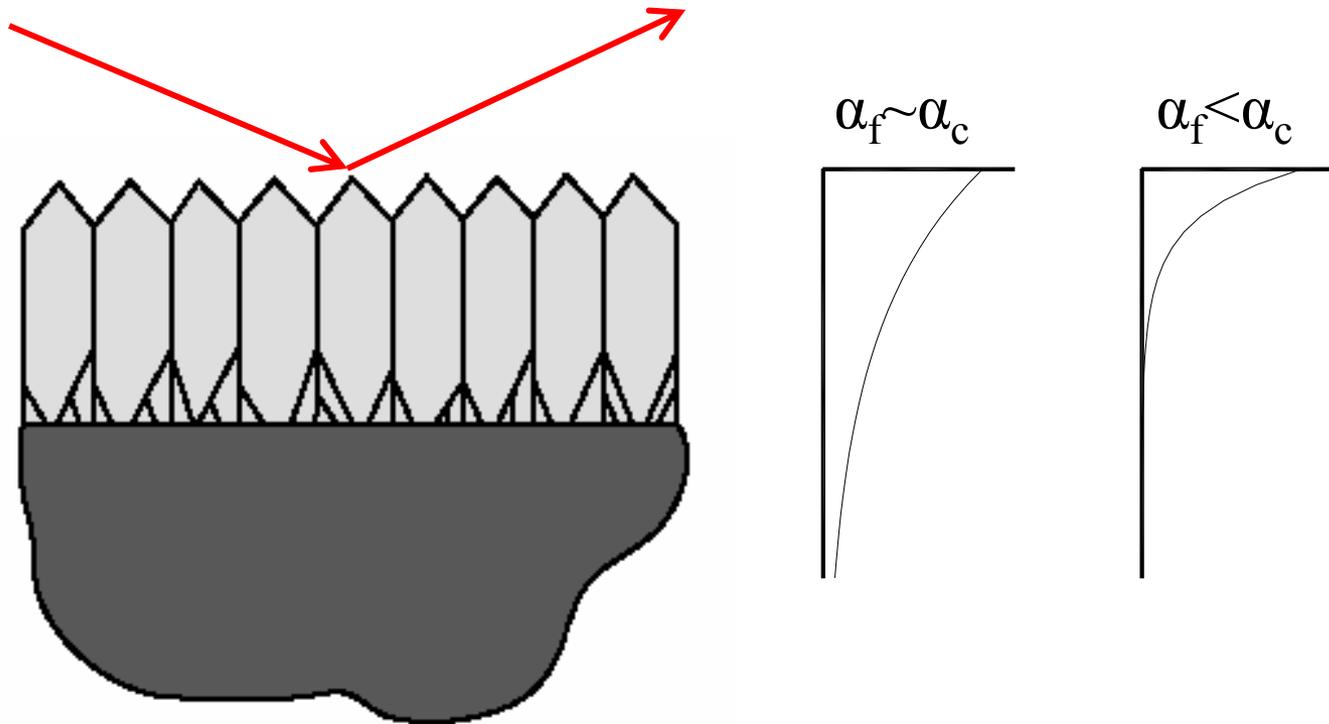
Structure in “Yoneda” Peak

Grazing-exit diffraction from a 1000Å Au polycrystalline film



Competitive Grain Growth

C. V. Thompson, *Ann. Rev. Mat. Sci.* **30** 159 (2000)

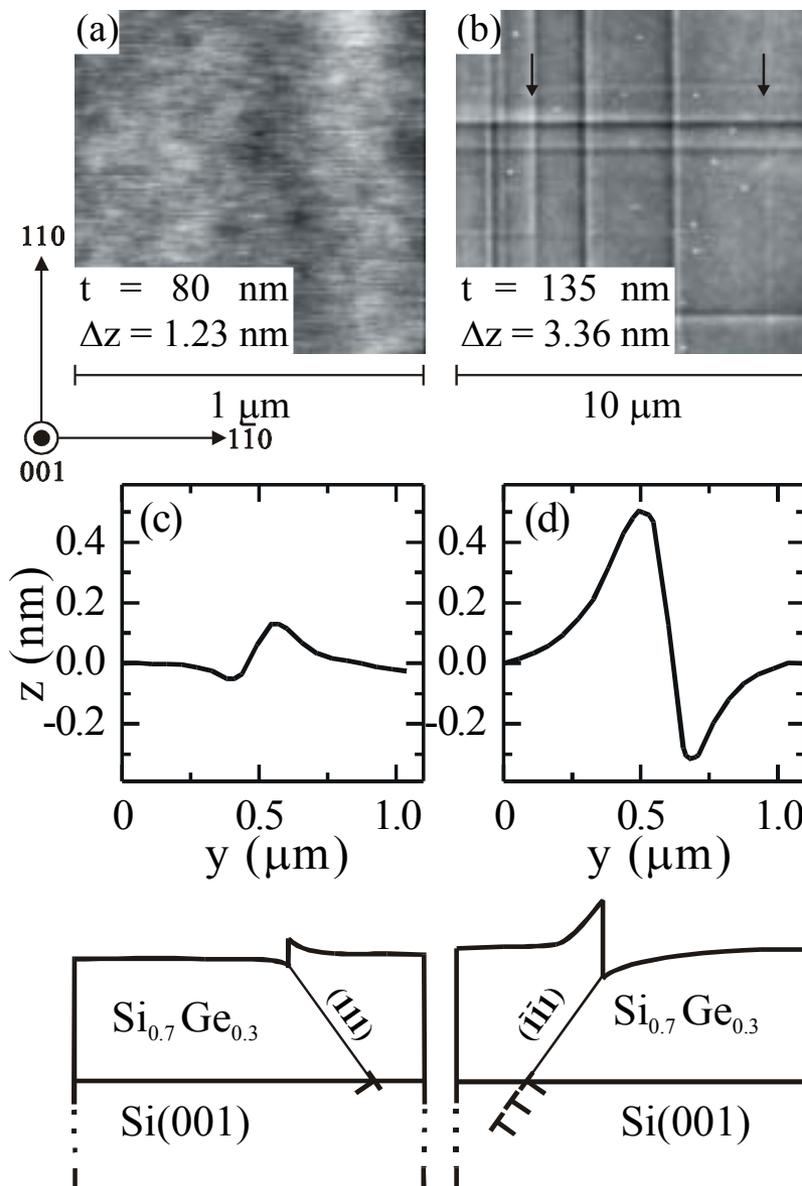


Low dislocation density GeSi films

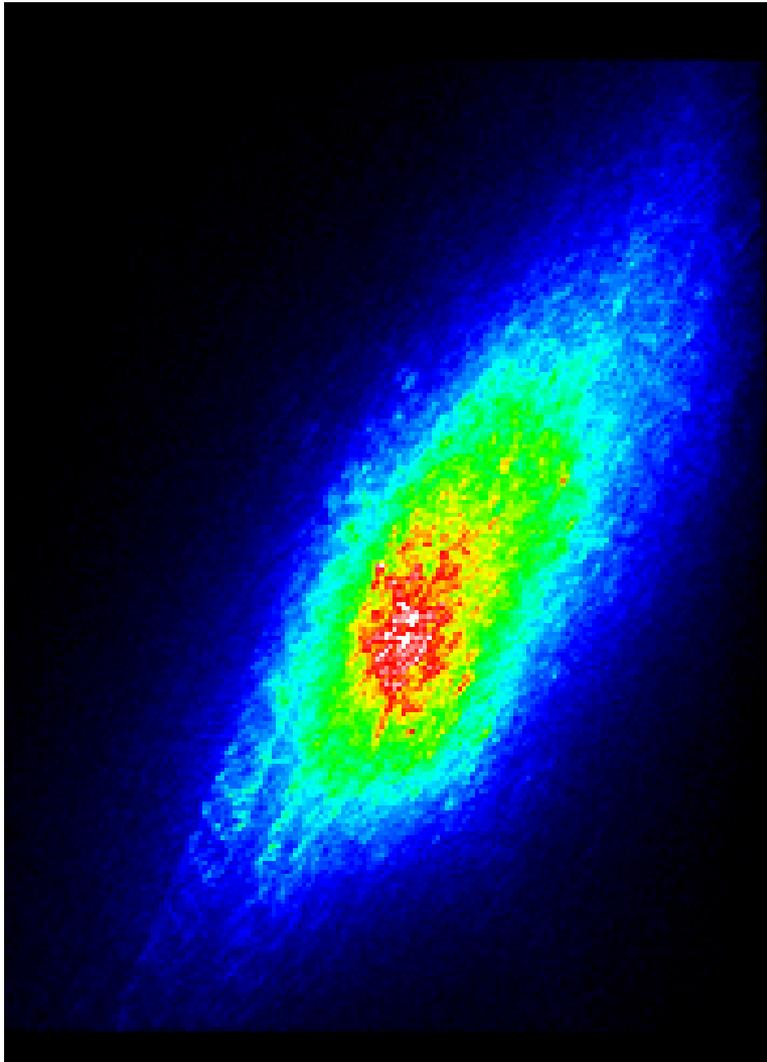
Thickness close to critical thickness

Dislocations aggregate at interface and glide to surface along $\{111\}$

T. Spila, UIUC Thesis



$\text{Ge}_x\text{Si}_{1-x}$ Film Diffraction



- 202 Bragg Peak
- 2800Å film
- 2° incidence angle
- 8.5 keV
- 20 μm \times 40 μm beam onto KB mirror
- 1 μm \times 1 μm focus
- 0.5 μm sample steps
- APS 34-ID-C

Conclusions and Outlook

- Inversion of CXD using oversampling
- Diffuse scattering acquires fine structure
- Internal structure of Au Nanocrystals
- Preservation of coherence upon focusing
- Image individual dislocation strain fields
- Localized manipulations of nanocrystals